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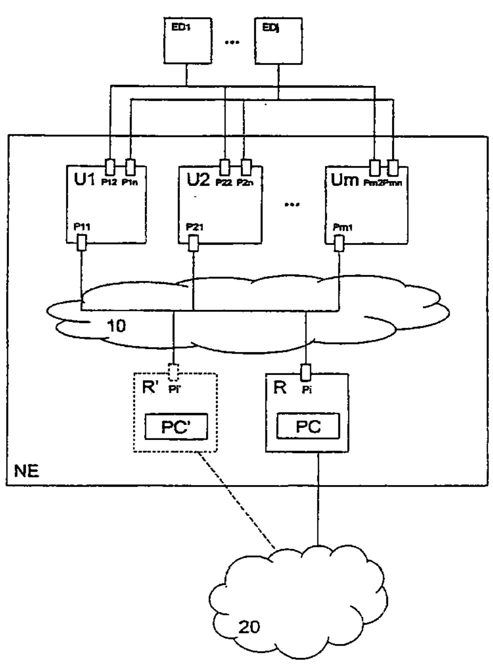
(54) Title: LAN-BASED INTER-UNIT COMMUNICATION



(57) Abstract: The present invention relates to a network element and an associated method, which facilitates communication of data frames between elemental devices (U1-Um) of a network element by using an LAN-based link system. Data applied to a port of a multi-port interface converter is formatted into a data frame which may selectively include a Q Tag Prefix populated with a VID (Virtual LAN Identifier) defined in the IEEE 802.1Q standard. If the data to be communicated by the multi-port interface converter is originated at the converter, the data is formatted into a data frame, but the prefix structure is not included, and therefore the frame is not populated with the VID. When the data frame is received at the router device, detection is made as to whether the data frame includes a prefix structure. Routing of the data of the data frame is made responsive to whether the prefix structure is formed of a VID contained in the data frame. Furthermore, an activity state of active and non-active units can be signaled using the proposed LAN-based link system. Thereby, communication between elemental devices of a network element can be facilitated and complexity can be reduced.

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Fig. 6 shows a schematic flow diagram of the protection switching function according to the second preferred embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiments relate to traffic communication between internal elemental devices (Units) of a multiple-devices network element NE, like an intelligent router, and at least one transport engine or other external entity ED1 to EDj, e.g. a base station.

Fig. 1 shows a schematic block diagram of such a network element NE according to the first preferred embodiment. For the internal data flow, the network element NE comprises an Ethernet LAN structure 10. From IP (Internet Protocol) point of view, this LAN 10 will be regarded as a single IP sub-net. According the invention, all elemental devices U1 to Um are only connected via standard compliant Ethernet point-to-point links, e.g. standardized fast Ethernet or G bit/s Ethernet, for complete communication between the elemental devices U1-Um. Thereby, the use of additional dedicated links performing a separate management network can be avoided.

A dedicated MAC address unique for each of the elemental device U1-Um is used to exchange every kind of information via this links of the LAN 10. Especially, control packets, e.g. Inter Unit (Device) Communication and Network Management Information, are combined with payload traffic originated and addressed to entities, e.g. the external entities ED1 to EDn, connected via a bus system or other network system, or to an IP network 20, external to the multiple-devices network element NE to one common transport stream between each device pair. Each of the elemental devices U1 to Um comprises a plurality of addressable ports Pi1-Pin to enable dedicated data flows via the LAN 10 or to the external entities ED1 to EDj, respectively. In the preferred embodiments, the elemental devices U1 to Um can

external location, here indicated by the external entities ED1-EDj and the IP network 20. A forwarding decision to forward the data frame is made, for instance, responsive to the VID contained in a tagged frame, and the frame is thereafter sent by way of another interface (not shown). And, once delivered to the appropriate layer 3 interface element, routing of forwarding decisions are made responsive to information, here VID, within the received data.

As two-way communication is permitted between the respective devices, each VLAN processor includes the frame encapsulating functionality 160 and also the analyzing functionality 120.

Fig. 3 shows a frame structure of a data frame into which data is frame-formatted by the frame encapsulating functionality 160 (shown in Fig. 2). The data frame, shown generally at 102, is exemplary of a tagged data frame according IEEE 802.1Q formed of externally-generated data applied to the transport element device to use in a VLAN . The data frame is formatted to include a header portion having after a preamble, not shown, a destination MAC address field 104, a source MAC address field 106, an Ether-type field 108, a tag control information field 112, and a MAC (Media Access Control) length/type field 114. A payload portion includes a data field 116, a PAD field 118 and an Frame Check Sequence FCS field 122. The data format corresponds to a format set forth in the IEEE 802.1Q standard protocol.

The tag control information field 112 includes a Q Tag Prefix 124 at which a VLAN identifier is selectively inserted pursuant to the preferred embodiment of the present invention. Here, when the data encapsulated by the frame encapsulating functionality 160 is originated external to the network element NE at one of the ports P12-P1n, P22-P2n and Pm2-Pmn thereof, the frame encapsulating functionality 160 populates the tag header field 124 with the VID associated with the port at which the data is received.

According to the preferred embodiments, when the data encapsulated into the frame is exchanged internally, i.e. internal management information, the frame should advantageously not include the Q Tag Prefix or not be populated with a VID value. Subsequent to communication of the data frames to the router unit R, the analyzation functionality 120 thereof searches in each received data frame for a Q Tag Prefix to determine the origin of the data frame. If the received data are not tagged or a Q Tag Prefix is not populated with a VID, the data contained in the frame is known, thereby, to have been originated at the respective elemental device for use by the router unit R.

In other words, data received at the ports P12-P1n, P22-P2n and Pm2-Pmn of an elemental device are encapsulated into a tagged Ethernet frame by the frame encapsulating functionality 160 of the respective VLAN processor. The destination address field is populated with the MAC address of the router unit R and a VLAN Q Tag Prefix is inserted into an added tag control information field 112 according to the IEEE 802.1Q protocol utilizing the VID associated with the appropriate port of the elemental device. The Ethernet frame is then communicated upon the Ethernet connection from the respective transmitting port.

Conversely, data which is generated at the internal information source 170 of an elemental device is formatted by the frame encapsulating function 160 into a data frame and communicated upon the Ethernet connection from the transmitting port without a VLAN Q Tag Prefix in a "non-tagged" frame. When the Q Tag Prefix of the data frame is not populated with the VID, any other device, which is unaware of any special functionality of the originating device, considers the device to behave as an ordinary device.

When a data frame is detected at the router unit R, whether a tagged or a non-tagged frame, analysis is made to determine whether the Q Tag Prefix includes a

VID. If the data frame is a non-tagged frame, the data contained therein is directly passed to a next-higher layer, as the data frame is indicated to have been received at the port Pi. If the data frame is a tagged data frame, noted to have been received at the port Pi, then the value of the VID is analyzed. Depending upon the value of the VID, the associated external port P12-P1n, P22-P2n and Pm2-Pmn at which the data contained in the data frame is originated is determined, and the data contained in the frame is passed on to a next-higher layer indicating on which port of the originating elemental device the data was received.

Communication of data is analogously effectuated at the routing unit R. Data is available in a higher-level layer, here designated as logical layer 3 data. Frame formatting is performed on the data by operation of the VLAN processor and all data frames are communicated from a data port of the device, such as the data port Pi, to a specific destination device, i.e. one of the elemental devices U1 to Um.

If the destination of data frames originated at the router unit R is one of the elemental devices U1 to Um, the data frames are communicated by way of a respective Ethernet connection of the LAN 10 subsequent to frame formatting operations at the VLAN processor. The Q Tag Prefix of the data frame is not populated with a VID, or the frame encapsulating functionality 160 of the router unit R generates a non-tagged frame. In another implementation, the data frame can be populated with a VID which identifies the transport element device. When the data frame is received at the selected elemental device, detection by the analyzing functionality 120 is utilized at the VLAN processor to determine whether a tag header field was inserted and is populated with a VID. If determination is made that the data frame forms a non-tagged data frame, the data is passed on to a higher logic level layer of the selected elemental device for further processing. If, conversely, the destination of the data frame is to a device coupled to the external ports P12-P1n, P22-P2n and Pm2-Pmn, then the tag header field is populated with a VID associated with the intended destination.

The VID is of characteristics specified pursuant to the IEEE 802.1Q standard. The VID is, therefore, of a 12-bit length and is positioned within the tag control information portion of the data frame set forth in the IEEE 802.1Q standard.

The data contained in the data frames is originated beyond the external interfaces P12-P1n, P22-P2n and Pm2-Pmn, and the Q Tag Prefix is populated with a corresponding VID. Higher-level logical layer data is communicated to the router unit R. As the Q Tag Prefix is populated with a VID, and the data frame is passed on to the higher-level logical layers of the router unit R for further processing thereat.

In the second preferred embodiment, the proposed LAN-based inter-unit communication architecture is used for providing a protection switching functionality. Here, signaling can also be effectuated between redundant elemental devices, formed of an active device, e.g. the router unit R and at least one stand-by device indicated in Fig. 1 as a dotted additional or redundant router unit R'. In particular, the protection or activity state of the redundant devices R, R' is signaled via the LAN 10 to indicate their respective status, i.e., active or stand-by. The signaling information flows by way of the internal Ethernet LAN 10 formed to extend between the redundant devices using periodic, added message Ethernet frames. It is however noted that the protection switching function can be provided for any other critical unit or elemental device of the network element NE.

Fig. 4 shows a schematic functional block diagram of the protection switching functionality according to the second preferred embodiment. In order to quickly activate the stand-by router unit R', a protection controller PC' in the stand-by router unit R' controls the active router unit R. Both devices utilize the same MAC- and the same IP-addresses by way of identical ports Pi, Pi' of the respective, connected devices. Both connections are terminated in each multi-interface unit of